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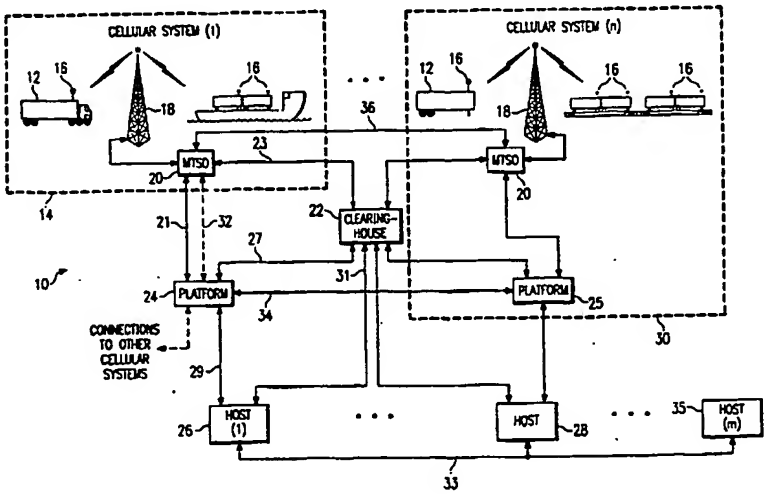

(57) Abstract

A messaging unit (16) equipped with a cellular transceiver (38) is attached to a truck trailer (12) located within a communications network (10). The messaging unit (16) generates a data message in response to the occurrence of a reporting event. Upon generation of a data message, the cellular transceiver (38) transmits the data message over the network (10) via voice or data channels. The data message is received at an MTSO (20) and then routed to a platform (24), a clearinghouse (22), or the platform (24) through the clearinghouse (22). The data message stored at the platform (24) or the clearinghouse (22) is accessed by a host (26). A data message may be sent over a voice channel of the network (10) subject to a handshake protocol between the messaging unit (16) and the platform (24). Data messages may also be sent over a data channel of the network (10) by altering the mobile identification number (MIN) or electronic serial number (ESN) of the cellular transceiver (38). Furthermore, data messages may be sent over a data channel of the network (10) by issuing a feature request with appended data digits.

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DATA MESSAGING IN A COMMUNICATIONS NETWORK

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to the field of telecommunications, and more particularly to data messaging in a communications network.

BACKGROUND OF THE INVENTION

The proliferation of sophisticated communications systems has resulted in developments in mobile communications and in particular mobile data messaging. Data messaging collectively refers to the transfer of information over voice or data channels of a communications network. One application of data messaging is the monitoring of a group of items by causing the items to send data messages to a remote location in response to a recognized reporting event. For example, a truck trailer monitoring system may use data messaging to collect information on the current position and status of a fleet of truck trailers.

A network of cellular telephone systems is a suitable conduit for such data messaging, especially if the monitored items are mobile, such as people, vehicles, or cargo containers. However, the cost of using traditional cellular communication is prohibitive, both in terms of chargeable air time and roamer fees.

Another problem with using traditional cellular networks for data messaging is that the fragmentation of cellular service providers results in disintegrated monitoring and control of cellular air traffic, which often contributes to fraudulent use of the cellular telephone network. Increasing incidents of roamer fraud adds significantly to the cost of cellular air time, especially for nation-wide users of the cellular telephone network. To combat these problems, cellular service providers are implementing authorization and verification procedures for validating roaming customers.

Therefore, a need has arisen for a communications network that handles a high volume of data messaging by exploiting the functionality of existing cellular telecommunications equipment, while reducing opportunities for fraud. In particular, a need has arisen for data messaging to monitor the position and status of a national fleet of truck trailers in the most cost effective and reliable manner.

SUMMARY OF THE INVENTION

In accordance with the teachings of the invention, a method and apparatus for data messaging in a communications network is provided which substantially eliminate or reduce disadvantages and problems associated with prior art data messaging systems. Furthermore, data messaging in a cellular telephone network to monitor the location and status information of a fleet of truck trailers substantially eliminates or reduces disadvantages and problems associated with prior art truck trailer monitoring systems.

In accordance with one aspect of the invention, a system for communicating data messages over a cellular telephone network contains a plurality of messaging units. Each messaging unit includes a processor that generates a data message upon the occurrence of a reporting event. Each messaging unit also contains a cellular transmitter that transmits the data message over the cellular telephone network. A platform coupled to the cellular telephone network receives data messages transmitted by the messaging units and stores the data messages in a storage device. A host coupled to the platform accesses data messages stored by the platform.

In accordance with another aspect of the invention, a messaging unit attached to a mobile item to be monitored sends data messages over a data channel of a cellular telephone network. The messaging unit includes a sensor located on the mobile item that generates information on the mobile item. A processor is coupled to the sensor and receives the information from the sensor. The processor generates a data message containing the information upon the occurrence of a

reporting event. A cellular transmitter coupled to the processor transmits the data message over a data channel of the cellular telephone network.

In accordance with another aspect of the invention, a method for data messaging over a cellular telephone network encodes an identifier of the cellular transmitter. Data messaging is initiated upon the occurrence of a reporting event. The identifier of the cellular transmitter is encoded with information on the reporting event. The encoded identifier is then transmitted through the cellular telephone network using the cellular transmitter and received at a remote location.

In accordance with another aspect of the invention, a method for data messaging over a cellular telephone network issues a feature request. Data messaging is initiated upon the occurrence of a reporting event. A feature request is then generated and data digits representing information on the reporting event are appended to the feature request. The feature request and data digits are then transmitted through the cellular telephone network and received at a remote location.

An important technical advantage of the invention is that data messages sent to or received from the messaging units over a voice channel of a cellular telephone network are subject to a verification procedure, thereby allowing for multiple levels of fraud protection. In particular, a handshake protocol is required when a data message is directed to or received from one of the messaging units, thereby preventing theft of cellular air time through roamer fraud.

Another important advantage of the invention is that messaging units can send data messages over a data channel of a cellular telephone network by altering the mobile identification number (MIN) or electronic serial number (ESN) of the cellular transmitter. By altering these cellular transmitter identifiers, the messaging unit can send information over existing cellular telecommunications equipment without opening a voice channel or dedicated data channel.

Still another important advantage of the invention is that messaging units can send data messages over a data channel of a cellular telephone network by issuing a feature request with appended data digits. The feature request is then routed through a data channel of a cellular telephone network to a remote data message gathering location.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a block diagram of a communications network for communicating a variety of data messages in accordance with the teachings of the invention;

FIGURE 2 is a block diagram of a messaging unit operating within the communications network for sending and receiving a variety of data messages in accordance with the teachings of the invention;

FIGURE 3 is a flow diagram for sending a data message over a voice channel of the communications network using a modem handshake protocol in accordance with the teachings of the invention; and

FIGURE 4 is a flow diagram for sending a data message over a data channel of the communications network in accordance with the teachings of the invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE 1 is a block diagram of a communications network 10. Located within cellular system 14 of network 10 is a truck trailer 12 carried by a cab, barge, train, or other suitable transportation system. It should be understood that the invention contemplates data messaging from any group of cargo containers, vehicles, persons, and other items whose location and status information are to be monitored.

Network 10 may be a cellular telephone network, but it may also be another type of communications system, such as a specialized mobile radio (SMR) system, a personal communication services (PCS) system, or any other suitable communications system. Furthermore, network 10 may be comprised of land-based transmission towers, space-based satellite transponders, or a combination of communications hardware in space or on land. Transmissions over network 10 may be analog or digital without departing from the scope of the invention.

Truck trailer 12 is equipped with a messaging unit 16, which contains a cellular transceiver for sending and receiving data messages. The design of messaging unit 16 is discussed in detail with reference to FIGURE 2. Cellular system 14 includes a transmission tower 18 and a mobile telecommunications switching office (MTSO) 20 coupled to the transmission tower 18. It should be understood that each cellular system 14 may comprise a plurality of transmission towers and a plurality of MTSOs.

MTSO 20 switches calls to and from the cellular system 14 and a land-based telecommunications system (not shown). MTSO 20 is also coupled to clearinghouse 22, which provides call information to MTSO 20 through data

link 23. For example, MTSO 20 can be configured to connect calls only if clearinghouse 22 provides, for example, validation information indicating that the cellular phone involved has good credit or is authorized to make calls. Clearinghouse 22 may also maintain other information, such as "roaming" phones' present locations and home systems. In existing cellular systems, companies such as GTE/TSI, EDS, and McCaw provide the clearinghouse function.

MTSO 20 is coupled to a telecommunications platform ("platform") 24 through a voice/data link 21. Pending U.S. Patent Application Serial No. 08/095,166, referenced above, describes in detail the construction and operation of the platform 24. Clearinghouse 22 is also coupled to platform 24 through data link 27 to provide platform 24 with information generated by clearinghouse 22. In turn, platform 24 is coupled to host 26 through voice/data link 29. Platform 24 may be coupled to any other host, such as host 28, through a similar voice/data link. Alternatively, hosts 26 and 28 may receive call information directly from clearinghouse 22 over data link 31.

Hosts 26 and 28 are shown for clarity, but it should be understood that many other hosts may be similarly coupled to platform 24, other platforms, other hosts, or clearinghouse 22. Link 33 between host 26 and host 28 allows hosts to exchange information. Host 35 may be connected to host 28 via link 33, such that host 35 receives information solely from host 28. In such a manner, designated hosts in network 10 act as central hosts to receive data messages and distribute these messages to other hosts.

FIGURE 1 illustrates another cellular system 30, which includes a separate transmission tower 18 and MTSO

20. Within the operating region of cellular system 30 are truck trailers 12 equipped with messaging units 16. A platform 25 may be associated with cellular system 30, illustrating that the platform functions can be performed at distributed locations throughout network 10. However, platform 24 may perform all platform functions for all cellular systems. Moreover, as shown in FIGURE 1, platform 24 may be coupled to one or more cellular systems. For example, platform 24 may be coupled to all of the east coast cellular systems. Likewise, platform 25 is a distributed platform, and is associated with and part of a particular cellular system. Platform 25, like platform 24, is coupled to a host, such as host 28.

Dashed line 32 indicates a link between MTSO 20 and platform 24. With a proposed standard (IS41, revision A), validation of a user can be performed prior to the placing of cellular calls. For example, at power up or upon first entry into a particular cellular system, a cellular transceiver can issue identifiers to MTSO 20 for pre-validation. Alternatively, MTSO 20 can poll a cellular transceiver to provide identifiers for validation and registration. The pre-validation information may be transmitted from MTSO 20 to clearinghouse 22 over data link 23. Likewise, platform 24 may perform the pre-validation without resort to an outside clearinghouse, over link 32. With pre-call validation performed by clearinghouse 22, later data messages can be sent directly to platform 24 over link 32. It should be understood that link 32 may be the same as voice/data link 21, a separate dedicated data link, or another communications link.

Data link 34 between platform 24 to platform 25 allows distributed platforms to exchange information regarding user validation, fraud management, systems

operation, and billing functions. The distributed platform embodiment also provides fault tolerant and traffic management features in network 10, not unlike those features found in conventional long-distance telephone systems. Thus, as is shown in FIGURE 1, telecommunications platforms may be centrally located or arranged in a distributed manner and connected by data link 34.

Throughout this description of the invention, host 26, platform 24, clearinghouse 22, MTSO 20, and cellular system 14 have been discussed as separate elements. It should be understood that each of these components are logical components, and they may be combined without physical separation. For example, the functions of platform 24 and host 26 may be accomplished at a single site. Furthermore, the functions of platform 24 and clearinghouse 22 may also be accomplished at a single site. References to cellular system 14, MTSO 20, clearinghouse 22, platform 24, and host 26 are to be understood as also referring to any cellular system, switch, clearinghouse, platform, and host, respectively, of network 10.

Also illustrated in FIGURE 1 is data link 36, which allows for data transfer between MTSOs of the cellular systems in network 10. Such a link may be an SS7 backbone link for linking cellular systems. Link 36 allows cellular systems to share information relating to validation, roaming, billing, call routing, and other functions performed by network 10. For example, one cellular system that knows the location of a particular cellular transceiver, such as the cellular transceiver in messaging unit 16, may share that information with other cellular systems. Platform 24 may tie into link 36

across link 21 or link 32 to access information exchanged among MTSOs of the cellular systems in network 10.

The description of FIGURE 1 references both data links and voice/data links. Data links, such as links 23, 27, 31, 34, and 36, allow transmission of data over a dedicated data channel. Voice/data links, such as links 21 and 29, support transmission of voice over a voice channel and transmission of data over a data channel. For example, a cellular telephone transmission over a voice/data link, such as a T1 transmission link, may employ digital transmission techniques to carry voice over a voice channel and data over a data channel, such as an overhead message stream. It should be understood that the invention contemplates any transmission technique over a voice/data link, whether digital or analog, that provides a voice channel and a data channel. Current systems used in the industry include the DS-1 standard used in the United States and the CCITT primary multiplex standard used in European telecommunication systems.

Another communications protocol contemplated by the invention, termed cellular digital packet data (CDPD), sends data in packets interspersed between voice transmissions. The data messages in this protocol may be carried in a reserved section of the digital bit stream or selectively placed to fill unoccupied sections of the digital bit stream. CDPD technology also supports delivery of data messages that is not real-time. This is accomplished by establishing delivery addresses, so a user may receive and store data messages at a designated address and retrieve the data messages at a later time for processing.

Voice/data links also support transmission of data over a voice channel using a modem, dual-tone

multifrequency ("DTMF") tones, or other suitable data encoder. The invention contemplates two ways to send a data message in network 10, data transmission over a data channel and data transmission over a voice channel using a data encoder. It should be understood that a dedicated data channel, such as link 34, could be replaced with a link that also allows voice transmission, without departing from the intended scope of the present invention.

In operation, network 10 allows data messages to be sent across cellular systems, such as cellular systems 14 and 30, in a variety of ways. Data messages sent to or received from messaging units 16 over a voice channel in network 10 must pass through platform 24 or 25, where they are subject to a handshake protocol to minimize cellular telephone fraud and maintain secured communications.

Data messages may also be sent to or received from messaging unit 16 over a data channel in network 10. As described below, these messages are packaged and sent over a data channel as part of the call data processing procedures. Like data messages sent over a voice channel of network 10, data messages sent over a data channel may also be subject to a security protocol. Each type of data messaging supported by network 10 will be discussed in detail with reference to FIGURES 3 and 4.

FIGURE 2 is a block diagram of a messaging unit 16 operating within network 10 of FIGURE 1. In one embodiment of the invention, messaging unit 16 may be attached to truck trailer 12. However, it should be understood that data messaging in network 10 is not limited to truck trailer monitoring systems. Messaging unit 16 may be attached to any mobile items to be

monitored, such as people, vehicles, or cargo containers.

As shown in FIGURE 2, cellular transceiver 38 is coupled to cellular transceiver bus 40. Cellular transceiver 38 receives and transmits signals across cellular antenna 42, including cellular transmission and reception of voice and data over the voice and data channels in network 10. Cellular transceiver 38 may be just a cellular transmitter equipped to transmit data messages or just a receiver equipped to receive data messages. It should be understood that further references to cellular transceiver 38 contemplate a transmitter, a receiver, or both.

Cellular transceiver bus 40 is coupled to one or more processors 44 through cellular interface drivers 46. Cellular interface drivers 46 provide the necessary protocol for communications between processor 44 and cellular transceiver 38.

A modem 48 allows processor 44 to receive and transmit digital communication over a voice channel in network 10, as received from and transmitted through cellular antenna 42 and cellular transceiver 38. Modem 48, or any suitable device, distinguishes between voice and data encoded on the voice channel, and handles the information accordingly.

Processor 44 is also coupled to a DTMF recognizer 50. DTMF recognizer 50 allows reception and transmission of DTMF data over a voice channel of network 10, as received from and transmitted through cellular antenna 42 and cellular transceiver 38. All data transmissions to or from messaging unit 16 can be made using DTMF data.

Processor 44 is also coupled to a read-only memory ("ROM") 52 and a random access memory ("RAM") 54. These memories are for storage of instructions and data for operation of processor 44. It should be understood that

the invention contemplates use of any other suitable storage devices (not shown) including, but not limited to, hard disk and floppy disk drives, optical disk drives, CD-ROM storage devices, tape backups, and plug-in memory modules. A real-time clock 56 provides processor 44 with time-of-day, day-of-week, month, or year information.

Messaging unit 16 allows for input of location information from a LORAN-C system, global positioning satellite (GPS) system, dead reckoning system, inertial navigation system, or any suitable system providing location information. A positioning system interface 58 provides location information to processor 44, as received from positioning system transceiver 60 through positioning system antenna 62. The location information sent to processor 44 from the positioning system can be either raw location data (for example, data directly received from a LORAN-C system) or processed location data. Therefore, the processing of raw location data can occur within the positioning system itself, within the positioning system interface 58, within processor 44, or transmitted through cellular transceiver 38 and cellular antenna 42 for later processing at platform 24 or host 26 of FIGURE 1.

Messaging unit 16 also allows for input of status information through sensor system 64. In one embodiment, sensor system 64 comprises sensors, controllers, and processors used to monitor various parameters of truck trailer 12, and operates to pass status information to processor 44. Sensor system 64 may monitor performance parameters of truck trailer 12, such as the temperature of a refrigerated compartment, battery voltage levels, or diagnostics of other truck trailer subsystems. Sensor system 64 may also monitor the status of truck trailer 12

and its contents, such as whether truck trailer 12 is connected to a cab and whether the contents have been tampered with. For purposes of this description, "sensor" refers to any device that furnishes processor 44 with location and status information, including a positioning system.

A power supply 66 powers the various components of messaging unit 16. For clarity, the power connections to the different components of messaging unit 16 are not shown. Power supply 66 is a power management system which may include a battery and charging circuitry. In addition, power supply 66 may include optional sources of power, such as an external power connection 68 from, for example, a truck electrical system interconnection cable or a solar cell 70 mounted on the roof of truck trailer 12.

As shown in the particular embodiment of FIGURE 2, solar cell 70, cellular antenna 42, and positioning system antenna 62 may be mounted directly on the truck trailer roof, while the other components of messaging unit 16 reside inside the cargo compartment. However, it should be understood that the invention contemplates any arrangement and placement of the components of messaging unit 16 in one or more separate housings attached to the mobile item to be monitored.

In operation, messaging unit 16 generates a data message to be sent over voice or data channels of network 10 upon the occurrence of a reporting event. The occurrence of a reporting event is determined by processor 44 executing a reporting event determination module 72, shown as a part of processor 44 in FIGURE 2. Upon the occurrence of a reporting event, processor 44 may immediately generate and transmit a data message or generate and store the data message for later

transmission. By storing data messages, messaging unit 16 may then send a batch of data messages chronicling the status of truck trailer 12 over a period of time.

One reporting event that may trigger generation of a data message is a time-out signal received by processor 44 from real-time clock 56. Therefore, messaging unit 16 may generate data messages and report location and status information for truck trailer 12 at a particular time interval, such as twice a day, every day, or every week. In addition, a reporting event may be an external request from a variety of sources, such as MTSO 20, clearinghouse 22, platform 24 and host 26, among others.

A reporting event may also be initiated by the truck trailer transportation equipment or its operator. For example, messaging unit 16 may generate and transmit a data message upon a signal, received by processor 44 from sensor system 64, indicating connection or disconnection from the cab. An operator of the transportation equipment may also manually request messaging unit 16 to send a data message.

A reporting event may occur in response to a performance or alarm signal received by sensor system 64 that is beyond predetermined limits. For example, a reporting event may be when the cargo temperature in a refrigerated truck trailer exceeds a certain minimum or maximum level. The predetermined limits that trigger a reporting event may be remotely configured from the clearinghouse 22, platform 24, or host 26. Processor 44 may also determine a reporting event upon improper access to the cargo hold, malfunctioning of truck trailer subsystems, or malfunctioning of messaging unit 16 itself.

Furthermore, a reporting event may be based on geographical information. For example, messaging unit 16

may generate a data message when the truck trailer location determined by the positioning system deviates from an expected truck trailer location. The expected location may be stored in memory such as ROM 52, RAM 54, or other storage device, computed by processor 44, or received from host 26 or platform 24.

In a similar manner, a reporting event may occur when truck trailer 12 approaches or crosses a city, state, or national border, or enters the service area of a cellular system. Therefore, processor 44 executing reporting event determination module 72 causes messaging unit 16 to generate a data message upon the occurrence of a reporting event. The reporting event may be based on time, external requests, sensor inputs, manual requests by the driver, geographical information, or any other event or condition that warrants reporting of a data message to host 26.

Upon determination of a reporting event, messaging unit 16 operates to transmit and receive a variety of data messages over network 10. The data messages may contain information that initiated the reporting event, such as a signal indicating connection of the truck trailer to a cab, and also other monitored information, such as the location of the truck trailer at the time of the reporting event. Ultimately data messages transmitted from messaging unit 16 are routed through platform 24, clearinghouse 22, or both and accessed by host 26, as shown in FIGURE 1. A data message may be communicated over network 10 using either a voice channel or a data channel.

Messaging unit 16, through control of processor 44 may transmit and receive data messages over a voice channel through platform 24. For clarity, the transmission or reception of data messages over a voice

channel, including handshaking, will be discussed in connection with modem transfers, it being understood that such transmissions can be made using DTMF tones or other data encoded on the voice channel.

The ability to require that all data messages communicated over a voice channel pass through platform 24 is an important advantage of the invention, and allows for modem handshaking between platform 24 and messaging unit 16. As shown in FIGURE 2, processor 44 runs instructions that execute a handshake protocol module 74 which establishes secure data modem communication with platform 24. The method to transmit data messages over a voice channel is described in more detail with reference to FIGURE 3.

Processor 44 also executes a MIN statusing module 76 and a feature request generation module 78, which allow messaging unit 16 to generate and transmit data messages over a data channel of network 10. As described below with reference to FIGURE 4, MIN statusing module 76 allows messaging unit 16 to encode status and location information by altering identifiers of cellular transceiver 38, such as the mobile identification number (MIN) or electronic serial number (ESN), transmitted over a data channel of network 10. Feature request generation module 78, also discussed with reference to FIGURE 4, is another method to send data messages over a data channel by appending to a feature request data digits representing status and location information.

Link 80 between processor 44 and the transportation system allows messaging unit 16 to send and receive communications to and from, for example, a truck cab. The link may allow two-way communications using a short range radio system, an infra-red (IR) coupling, a direct connection through signal wires, or other appropriate

technology. Alternatively, the link may be a one-way communications link that allows messaging unit 16 to send data messages for transmission by the transportation system. In one embodiment, a one-way link may allow a scanner attached to the transportation system to identify the attached truck trailer 12.

Functionally, link 80 allows components of messaging unit 16 to be divided between the mobile item and its transportation system. In one embodiment, processor 44 residing on the mobile item generates a data message and then sends this data message over link 80 for transmission by cellular transceiver 38 located on the transportation system. In such a manner, the cost of outfitting mobile items with data messaging capabilities may be reduced by placing components of messaging unit 16 on the transportation system. It should be understood that the invention contemplates any arrangement of components of messaging unit 16 on the mobile item and the transportation system.

FIGURE 3 is a flow diagram for sending a data message generated by messaging unit 16 over a voice channel of network 10 using a modem handshake protocol. The method begins at block 100 which determines whether one of a variety of reporting events has occurred, as determined by processor 44 running reporting event determination module 72. If no reporting event has occurred, the method loops back in a continuous fashion to monitor the existence of a reporting event. When a reporting event occurs, block 102 generates a data message. The data message may contain location and status information of truck trailer 12 in a standard data package for transmission by modem 48. It should be understood that the invention contemplates any suitable

modem transfer protocol and compression technique to prepare the data for transmission by modem 48.

The method of FIGURE 3 then proceeds to block 104 where messaging unit 16 establishes a data modem connection with platform 24 over a voice channel of voice/data link 21 or 32. Data modem connection establishes the parameters for communication, such as baud rate, parity, and number of stop bits. After the connection is established, block 106 initiates a modem handshake between messaging unit 16 and platform 24. The modem handshaking proceeds in accordance with the teachings of pending U.S. Patent Application No. 08/095,166 entitled "Method and Apparatus for a Nation-Wide Cellular Telephone Network," referenced above. If messaging unit 16 does not pass the modem handshake and establish secure communications with platform 24, the method proceeds to block 108, where the communication is disconnected. At block 110, messaging unit 16 may try to reestablish a data modem connection and retry modem handshaking. Alternatively, the process may be reset for detection of another reporting event at block 100.

Upon successful modem handshake, the method proceeds to block 112 where modem 48 downloads the contents of the data message into a storage device in platform 24. The data may be time-stamped and stored as an entry in a log of data messages from messaging unit 16. Platform 24 can also index received data messages by an identification number of messaging unit 16 or cellular transceiver 38 received during modem handshaking at block 106. At block 114, an external device, such as a dispatcher's computer at host 26, can access the stored data messages and update a record of the location and status of mobile items equipped with messaging unit 16.

FIGURE 4 is a flow diagram for sending a data message over a data channel of network 10 using either the MIN statusing 76 or feature request generation 78 modules of processor 44. Unlike data messaging using modem data or DTMF tones, the following discussion describes transmission of data messages through network 10 without opening a voice channel. Furthermore, the data messaging techniques described below can be routed through clearinghouse 22, platform 24, or both clearinghouse 22 and platform 24.

The method of FIGURE 4 begins at block 116 which determines whether a reporting event has occurred by executing reporting event determination module 72 in processor 44. If no reporting event has occurred, the method continues to monitor sensor system 64, real-time clock 56, location data received from positioning system interface 58, and other inputs to determine if a reporting event has occurred.

Upon the occurrence of a reporting event, block 118 generates a data message. As described above, data messages may be created and sent immediately or created and stored for later transmission by messaging unit 16. A data message for transmission over a data channel of network 10 may be generated in two ways. First, location and status information can be encoded by altering identifiers of cellular transceiver 38, such as the mobile identification number (MIN) or electronic serial number (ESN). A second way to generate a data message is by dialing a feature request and appending location and status information in digits of data within the feature request. These two different ways of generating a data message are described in detail below.

The process to alter identifiers of a cellular transceiver 38 to transmit a data message, termed MIN statusing, begins with identification of the event to be reported and a translation of this event into a coded number. For example, assume processor 44 of messaging unit 16 receives a reporting event signal from sensor system 64 indicating that the temperature in the refrigerator compartment of truck trailer 12 is too high. Processor 44 translates the reporting event into, for example, a two-digit status code "39". The MIN of cellular transceiver 38 may be altered to include status code "39" in a designated data field. For example, if the current MIN is "099 881 1234", then the new altered MIN with the embedded status code may be "099 880 0039". The prefix "880" indicates that the MIN has been altered to convey status or location information, and the last four digits contain the encoded location or status information in the form of a two-digit status code "39".

The MIN of cellular transceiver 38 is altered to include a data message, but the ESN remains fixed to be used as an identifier of the messaging unit 16 that sends the data message. Therefore, upon receipt of the MIN/ESN, clearinghouse 22 or platform 24 can identify the messaging unit 16 by the ESN and can also receive status and location information encoded in the MIN. Alternatively, processor 44 can alter the ESN of cellular transceiver 38 and keep the MIN constant. It should be understood that the invention contemplates modification of the MIN, ESN, both the MIN and ESN, or other identifiers of cellular transceiver 38 to accomplish the dual task of encoding location or status information and identifying messaging unit 16.

Cellular transceiver 38 may transmit identifiers to MTSO 20 upon a call, feature request, pre-call

validation, or other communication between cellular transceiver 38 and MTSO 20. Therefore, the MIN statusing techniques of the invention can be used alone or in connection with feature request data messaging, data messaging over a voice channel of network 10, or any other data messaging technique that also transmits identifiers of cellular transceiver 38.

A second way to generate a data message at block 118 is to use a feature request and append location and status information in designated data digits of the feature request. Feature requests come in several varieties. For example, some feature requests are intercepted and acted upon by MTSO 20, such as "*18" and "*19" used to establish and disconnect roaming services. Other feature requests, such as programmed speed dial numbers, are equivalent to dialing a telephone number.

A dedicated feature request intercepted by MTSO 20 may be specifically implemented to transmit data messages. Such dedicated feature requests allow messaging unit 16 to send detailed data messages containing, for example, accurate location information generated by the positioning system. As an example, a data messaging feature request termed "*71" is generated by automatically or manually dialing the star key "*", a two-digit feature request identification code "71", and 29 digits of data. Furthermore, cellular transceiver 38 automatically appends the MIN/ESN to a feature request transmission. Such a feature request generated by messaging unit 16 and sent over a data channel of the cellular system would allow appended data messages of up to 29 digits.

Upon generating a data message using either MIN statusing 76 or feature request generation 78, the method of FIGURE 4 proceeds to block 120 where MTSO 20 receives

the data message. MTSO 20 may directly recognize the MIN/ESN or feature request identification code as identifying a data message from messaging unit 16. For example, MTSO 20 may be directed to recognize and process in a special manner all communications from a particular predetermined MIN/ESN, such as all MINs beginning with "099 880". Alternatively, MTSO 20 may be directed to recognize and process in a special manner all feature request transmissions with a particular feature request identification code, such as "71".

In another embodiment, MTSO 20 may contain a separate processor that indirectly monitors the call transactions through MTSO 20. The separate processor may also recognize and process data messages from messaging unit 16 in the same manner described above. In either situation, MTSO 20 appends a mobile serving carrier I.D. ("MSCID") to the MIN/ESN at block 122 and routes the data message to clearinghouse 22 over data link 23 or platform 24 over voice/data link 21 or 32.

In one embodiment, the data message is received directly at clearinghouse 22, as shown in block 124. In another embodiment shown in block 126, the data message is received at platform 24 directly through voice/data links 21 or 32, or indirectly through data link 27 from clearinghouse 22. An optional security protocol is performed at block 127 to ensure the authenticity of the data message. At block 128, the method identifies the particular messaging unit 16 that is reporting the data message using the MIN/ESN or other identifiers of cellular transceiver 38 or messaging unit 16. The data message is then translated or decoded to determine the status or location information reported by messaging unit 16.

The method of FIGURE 4 continues at block 130 where each data message may be time-stamped, indexed by identification number, and stored for later retrieval. The method of FIGURE 4 concludes at block 132, where an external device, such as a dispatcher's computer at host 26, can access the stored data messages and update a record of the location and status of items equipped with messaging unit 16, and thus allow appropriate responses to the data messages.

Throughout the discussion of FIGURES 3 and 4, the data messages are transmitted by messaging unit 16 to be collected at a central location, such as clearinghouse 22, platform 24, or host 26. It should be understood that messaging unit 16 equipped with cellular transceiver 38 may also receive data messages from a central location. The data messages may be sent from a central location to messaging unit 16 over a voice or data channel of network 10 and in a similar manner as described above with reference to FIGURES 3 and 4. For example, data messages received by messaging unit 16 may be sent over a data channel using MIN statusing or feature request generation, or over a voice channel using a data encoder, such as a modem or DTMF recognizer. Received data messages at messaging unit 16 may serve a variety of functions, such as remotely programming predetermined sensor reporting limits, updating messaging unit 16 software, requesting information, or alerting the operator of the transportation system, among others.

There have been described certain embodiments of the invention that are capable of data messaging in a communications network. While these embodiments have been described and disclosed, other changes, substitutions, or alterations can be made without

departing from the spirit and scope of the invention, as described in the appended claims.

WHAT IS CLAIMED IS:

1. A system for communicating data messages over a cellular telephone network, comprising:

a plurality of messaging units, each messaging unit comprising a processor operable to generate a data message upon the occurrence of a reporting event, each messaging unit further comprising a cellular transmitter operable to transmit the data message over the cellular telephone network;

a platform coupled to the cellular telephone network and operable to receive data messages transmitted by the messaging units, the platform further comprising a storage device for storing data messages; and

a host coupled to the platform and operable to access data messages stored by the platform.

2. The system of Claim 1, wherein each messaging unit further comprises circuitry for generating the data message by encoding an identifier of the cellular transmitter with information on the reporting event.

3. The system of Claim 1, wherein each messaging unit further comprises circuitry for generating the data message by appending to a feature request data digits representing information on the reporting event.

4. The system of Claim 1, and further comprising a switch coupled to the platform and operable to recognize data messages, and upon recognition, route data messages to the platform.

5. The system of Claim 1, wherein the platform further comprises circuitry for identifying the messaging unit that sent a particular data message.

6. The system of Claim 1, wherein each messaging unit is attached to a trucking trailer located within a service area of the cellular telephone network.

7. The system of Claim 1, wherein the cellular transmitter is operable to transmit the data message over a data channel of the cellular telephone network.

8. The system of Claim 1, wherein the cellular transmitter is operable to transmit the data message over a voice channel of the cellular telephone network using a data encoder.

9. A messaging unit for sending data messages over a data channel of a cellular telephone network, the messaging unit attached to a mobile item to be monitored comprising:

a sensor located on the mobile item and operable to generate information on the mobile item;

a processor coupled to the sensor and operable to receive the information from the sensor, the processor further operable to generate a data message containing the information upon the occurrence of a reporting event; and

a cellular transmitter coupled to the processor and operable to transmit the data message over a data channel of the cellular telephone network.

10. The messaging unit of Claim 9, wherein the sensor is a positioning system that generates location information of the mobile item.

11. The messaging unit of Claim 9, wherein the sensor is a performance sensor that monitors the performance of the mobile item.

12. The messaging unit of Claim 9, wherein the processor further comprises circuitry for generating the data message by encoding an identifier of the cellular transmitter with information from the sensor.

13. The messaging unit of Claim 9, wherein the processor further comprises circuitry for generating the data message by appending to a feature request data digits representing information from the sensor.

14. A method for data messaging over a cellular telephone network by encoding an identifier of a cellular transmitter, comprising:

initiating data messaging upon the occurrence of a reporting event;

encoding the identifier of the cellular transmitter with information on the reporting event;

transmitting the encoded identifier through the cellular telephone network using the cellular transmitter; and

receiving the encoded identifier at a remote location.

15. The method of Claim 14, wherein the step of initiating data messaging occurs upon receiving a time-out signal from a real-time clock.

16. The method of Claim 14, wherein the step of initiating data messaging occurs upon receiving a sensor signal beyond predetermined limits.

17. The method of Claim 14, wherein the step of initiating data messaging occurs upon receiving location information.

18. The method of Claim 14, wherein the step of initiating data messaging occurs upon receiving a request to initiate data messaging.

19. The method of Claim 14, wherein the step of encoding the identifier of the cellular transmitter comprises encoding the mobile identification number of the cellular transmitter with information on the reporting event.

20. The method of Claim 14, wherein the step of encoding the identifier of the cellular transmitter comprises encoding the electronic serial number of the cellular transmitter with information on the reporting event.

21. The method of Claim 14, wherein the step of transmitting the encoded identifier is initiated by dialing a telephone number.

22. The method of Claim 14, wherein the step of transmitting the encoded identifier is initiated by issuing a feature request.

23. The method of Claim 14, wherein the step of transmitting the encoded identifier is performed during pre-call validation communication.

24. The method of Claim 14, and further comprising the following steps performed at the remote location:

identifying the cellular transmitter transmitting the encoded identifier;

decoding the encoded identifier into information on the reporting event; and

storing information on the reporting event indexed by cellular transmitter.

25. The method of Claim 14, wherein the cellular transmitter is located on a truck trailer.

26. A method for data messaging over a cellular telephone network by issuing a feature request, comprising:

initiating data messaging upon the occurrence of a reporting event;

generating a feature request;

appending to the feature request data digits representing information on the reporting event;

transmitting the feature request and data digits through the cellular telephone network; and

receiving the feature request and data digits at a remote location.

27. The method of Claim 26, wherein the step of initiating data messaging occurs upon receiving a time-out signal from a real-time clock.

28. The method of Claim 26, wherein the step of initiating data messaging occurs upon receiving a sensor signal beyond predetermined limits.

29. The method of Claim 26, wherein the step of initiating data messaging occurs upon receiving location information.

30. The method of Claim 26, wherein the step of initiating data messaging occurs upon receiving a request to initiate a reporting event.

31. The method of Claim 26 wherein the step of generating a feature request comprises dialing a star key followed by a two-digit code.

32. The method of Claim 26, and further comprising the following steps performed at the remote location:

identifying a cellular transmitter transmitting the feature request and data digits;

decoding the data digits into information on the reporting event; and

storing information on the reporting event indexed by cellular transmitter.

33. The method of Claim 26, wherein the cellular transmitter is located on a truck trailer.

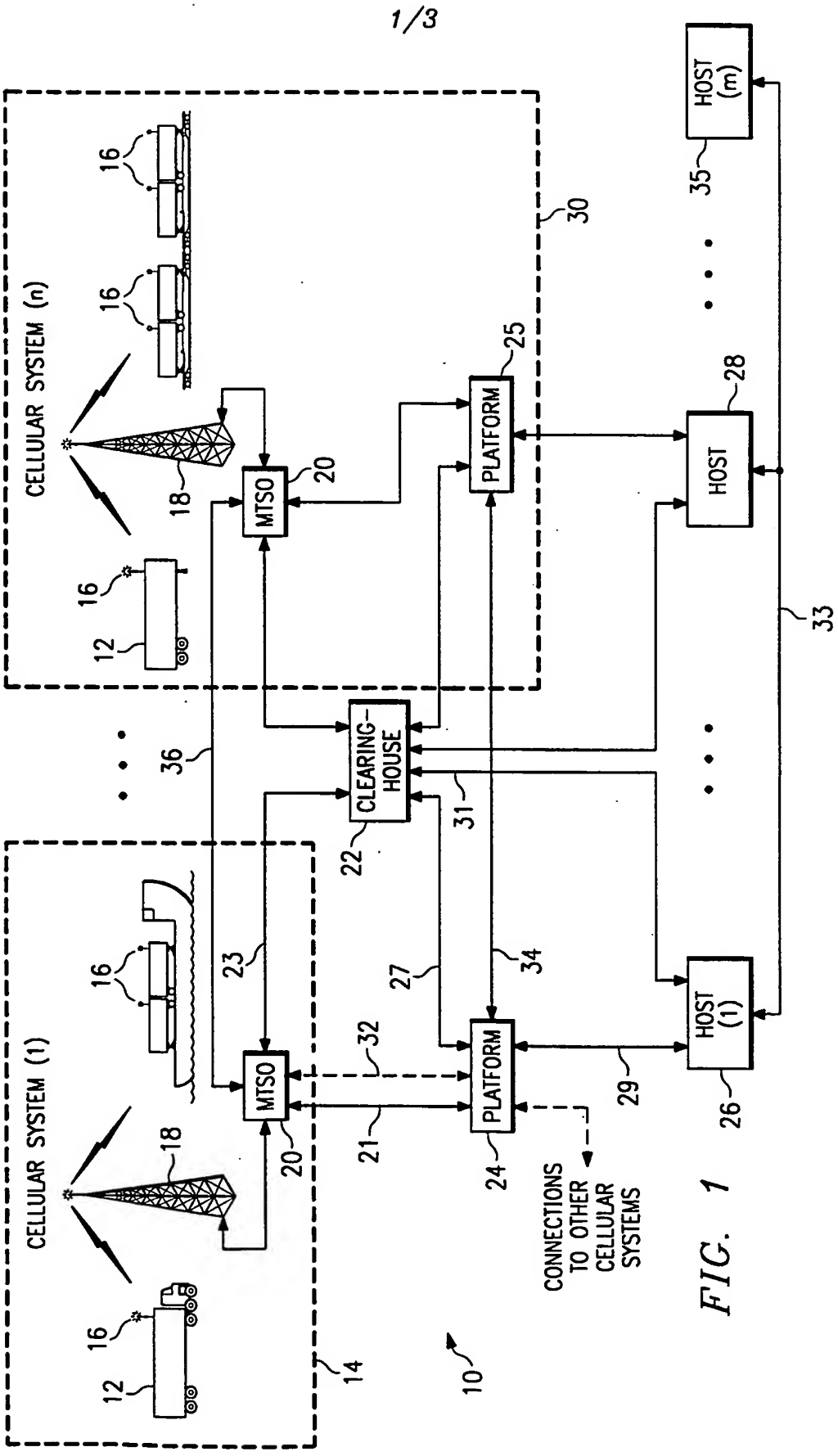
CELLULAR SYSTEM (n)
CELLULAR SYSTEM (1)
MTSO
MTSO
PLATFORM
PLATFORM
CLEARING-HOUSE
HOST
HOST (1)
HOST (m)
CONNECTIONS TO OTHER CELLULAR SYSTEMS
10
12
14
16
18
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

FIG. 1

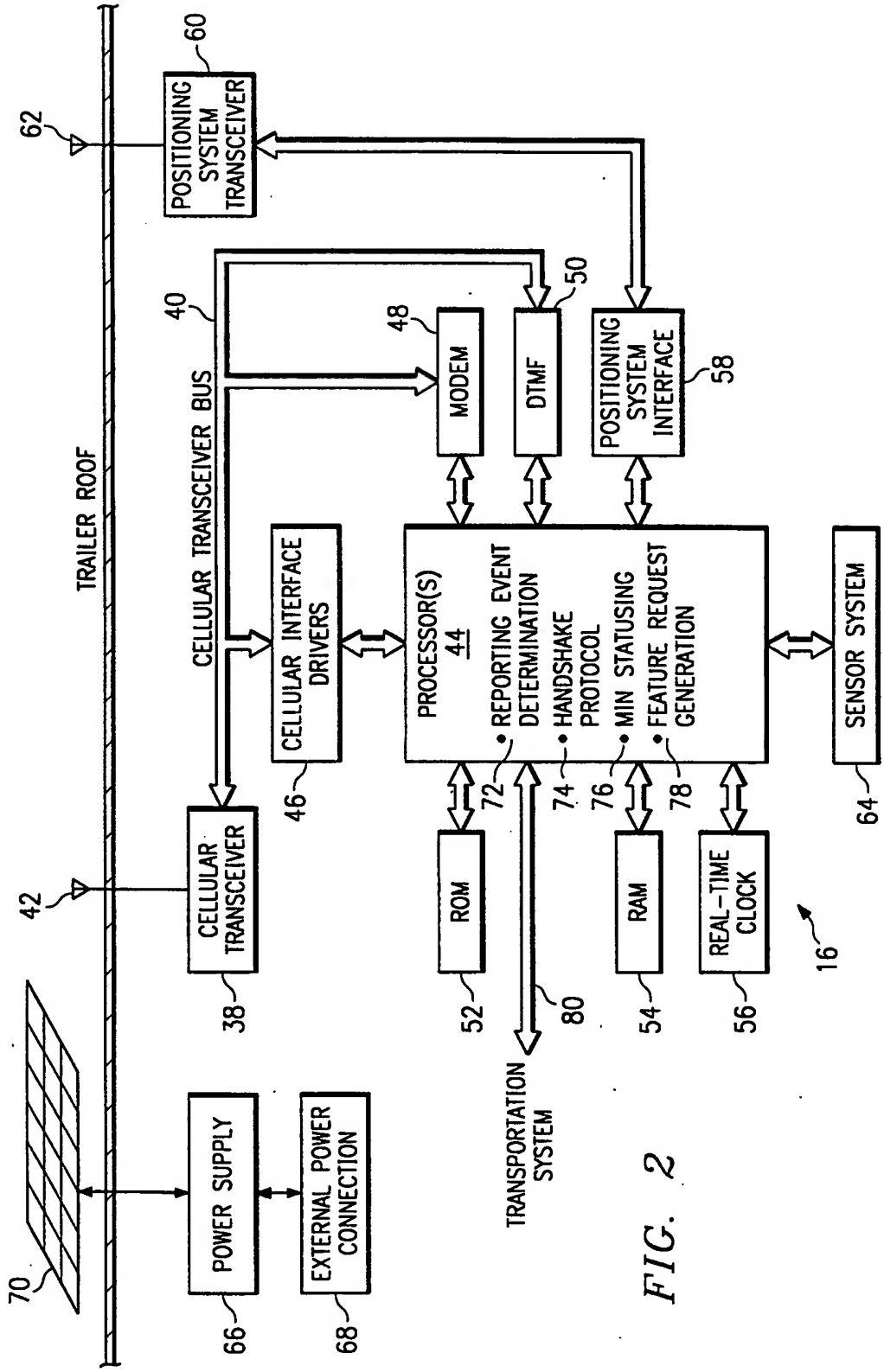
TRAILER ROOF
POSITIONING SYSTEM TRANSCEIVER
60
62
CELLULAR TRANSCEIVER BUS
40
MODEM
48
DTMF
50
POSITIONING SYSTEM INTERFACE
58
CELLULAR INTERFACE DRIVERS
46
PROCESSOR(S) 44
• REPORTING EVENT DETERMINATION
• HANDSHAKE PROTOCOL
• MIN STATUSING
• FEATURE REQUEST GENERATION
72
74
76
78
SENSOR SYSTEM
64
CELLULAR TRANSCEIVER
42
38
ROM
52
RAM
54
REAL-TIME CLOCK
56
16
80
TRANSPORTATION SYSTEM
POWER SUPPLY
66
EXTERNAL POWER CONNECTION
68
70

FIG. 2

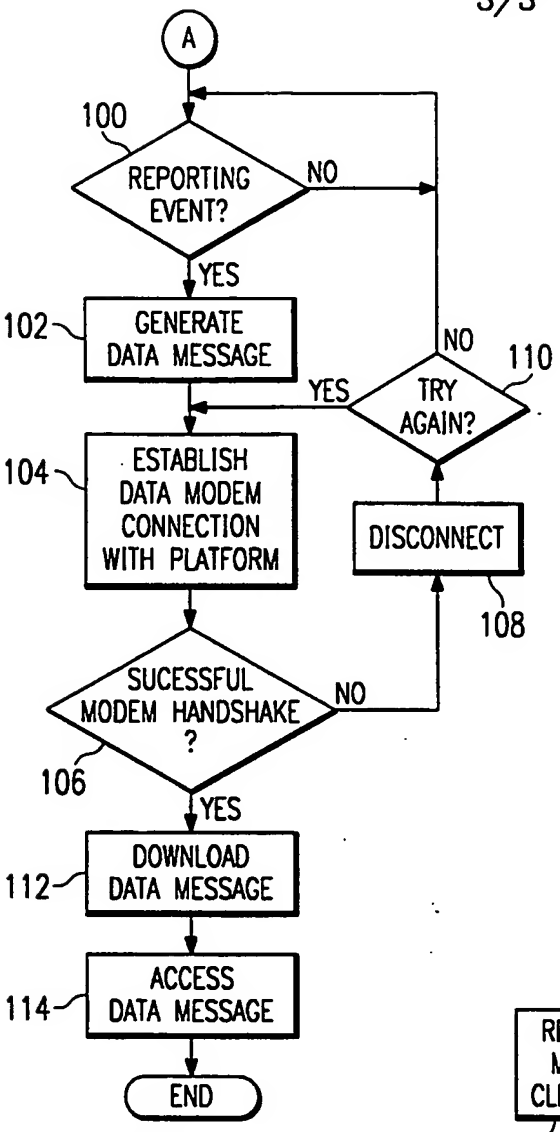
A
100
REPORTING EVENT?
NO
YES
102
GENERATE DATA MESSAGE
NO
110
TRY AGAIN?
YES
104
ESTABLISH DATA MODEM CONNECTION WITH PLATFORM
DISCONNECT
108
SUCESSFUL MODEM HANDSHAKE ?
NO
106
YES
112
DOWNLOAD DATA MESSAGE
114
ACCESS DATA MESSAGE
END

FIG. 3

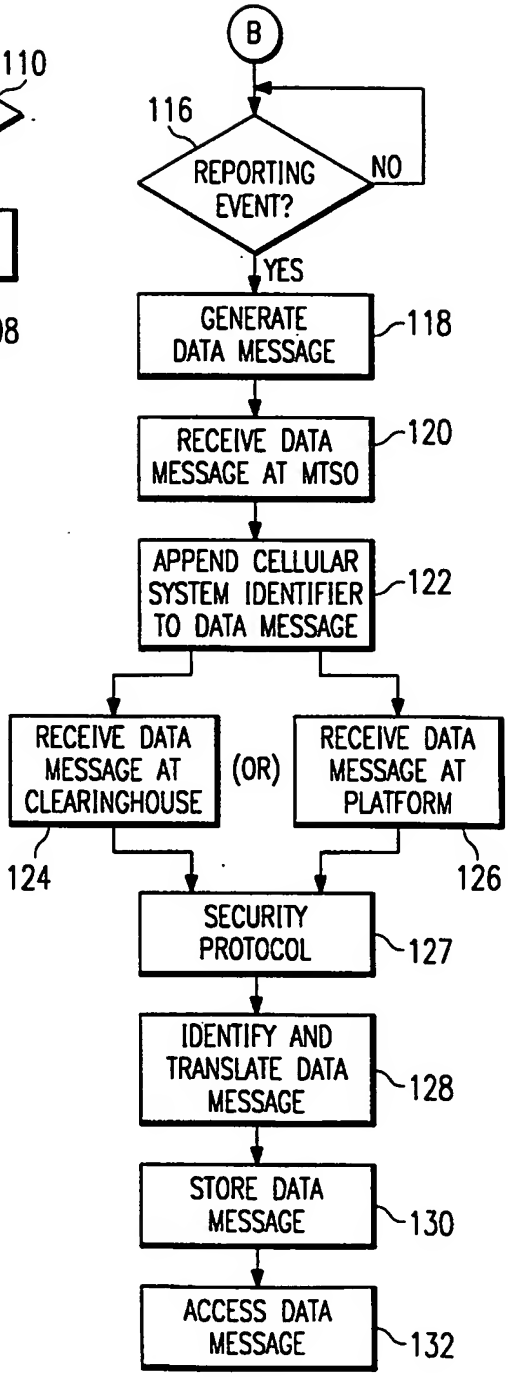
B
116
REPORTING EVENT?
NO
YES
GENERATE DATA MESSAGE
118
RECEIVE DATA MESSAGE AT MTSO
120
APPEND CELLULAR SYSTEM IDENTIFIER TO DATA MESSAGE
122
RECEIVE DATA MESSAGE AT CLEARINGHOUSE
(OR)
RECEIVE DATA MESSAGE AT PLATFORM
124
126
SECURITY PROTOCOL
127
IDENTIFY AND TRANSLATE DATA MESSAGE
128
STORE DATA MESSAGE
130
ACCESS DATA MESSAGE
132

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/08346

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :IPC(5): H04M 11/00
US CL :379/59
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/59,58; 455/33.1; 340/425.5, 426, 431, 531, 539

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US, A, 4,750,197 (DENEKAMP et al.) 07 June 1988, see col. 5, line 55 to col. 12, line 30.	1, 4-6, 8 --- 2, 3, 7, 9-33
X -- Y	US, A, 4,688,244 (HANNON et al.) 18 August 1987, see col. 5, line 30 to col. 10, line 64.	1, 4-6, 8 --- 2, 3, 7, 9-33
Y	US, A, 4,897,642 (DILULLO et al.) 30 January 1990, see col. 1, line 63 to col. 4, line 2.	1-33

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 01 SEPTEMBER 1994	Date of mailing of the international search report OCT 27 1994
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer GEORGE OHELING Telephone No. (703) 305-4835

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